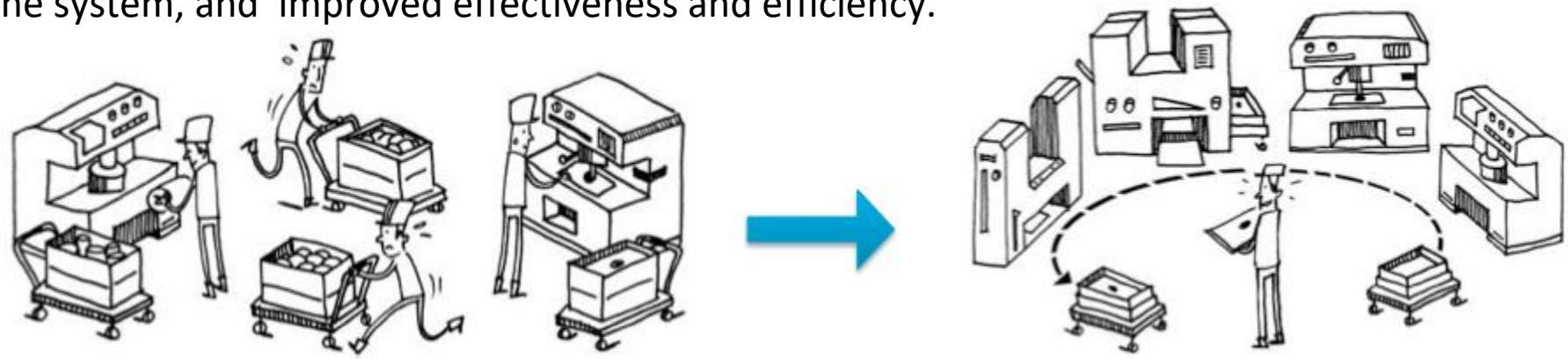
Facility Layout Design

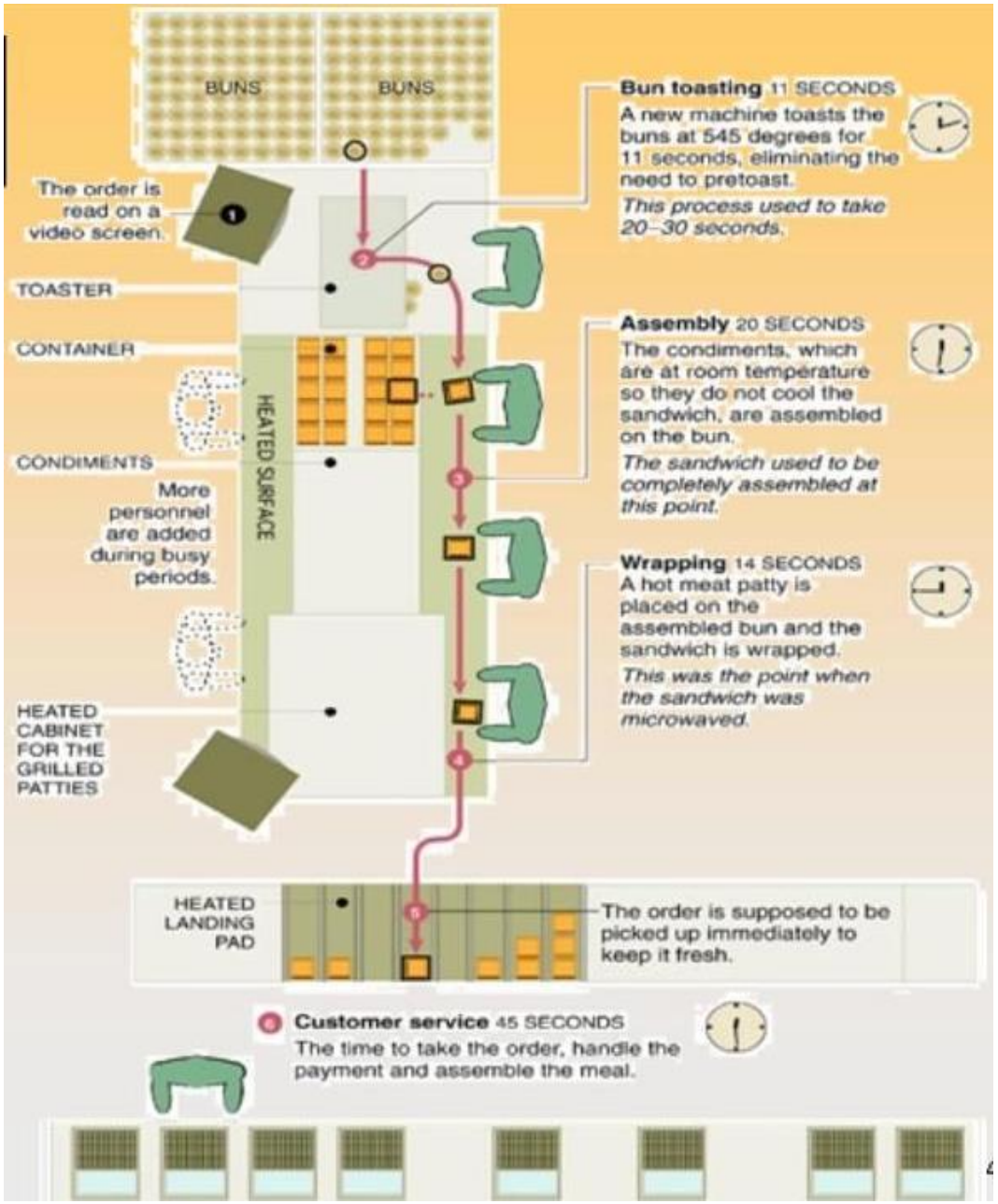
Layout Design: the arrangement of departments, work centers, equipment, in a facility/factory/plant. An effective layout will enable organizations to meeting competitive needs via smooth movement (of work, people, materials, info) through the system, and improved effectiveness and efficiency.



Layout Innovations at McDonald's

- Indoor seating (1950s)
- Drive-through window (1970s)
- Adding play areas (late 1980s)
- Redesign of the kitchens (1990s)
- Self-service kiosk (2004)
- Now three separate dining sections

McDonald's


BUNS
BUNS
The order is read on a video screen.
TOASTER
CONTAINER
CONDIMENTS
More personnel are added during busy periods.
HEATED SURFACE
HEATED CABINET FOR THE GRILLED PATTIES
HEATED LANDING PAD
Bun toasting 11 SECONDS
A new machine toasts the buns at 545 degrees for 11 seconds, eliminating the need to pretoast.
This process used to take 20–30 seconds.
Assembly 20 SECONDS
The condiments, which are at room temperature so they do not cool the sandwich, are assembled on the bun.
The sandwich used to be completely assembled at this point.
Wrapping 14 SECONDS
A hot meat patty is placed on the assembled bun and the sandwich is wrapped.
This was the point when the sandwich was microwaved.
The order is supposed to be picked up immediately to keep it fresh.
Customer service 45 SECONDS
The time to take the order, handle the payment and assemble the meal.

Topic Exploration

Layout Strategies
1. Explain the strategic importance of layout decisions.
2. Explain each of the layout types, provide some examples, and discuss considerations: office layout
3. Explain each of the layout types, provide some examples, and discuss considerations: retail layout
4. Explain each of the layout types, provide some examples, and discuss considerations: warehouse layout
5. Explain each of the layout types, provide some examples, and discuss considerations: fixed-position layout.
6. Explain each of the layout types, provide some examples, and discuss considerations: process-oriented layout
7. Explain each of the layout types, provide some examples, and discuss considerations: work-cell layout
8. Explain each of the layout types, provide some examples, and discuss considerations: repetative and product-oriented layout

1. Explain the strategic importance of layout decisions.

Strategic Importance of Layout Decisions

The objective of layout strategy is to develop an effective and efficient layout that will meet the firm's competitive requirements. Layout decisions can impact:

- Higher utilization of space, equipment, and people
- Improved flow of information, materials, or people
- Improved employee morale and safer working conditions
- Improved customer/client interaction
- Flexibility

Office Layout

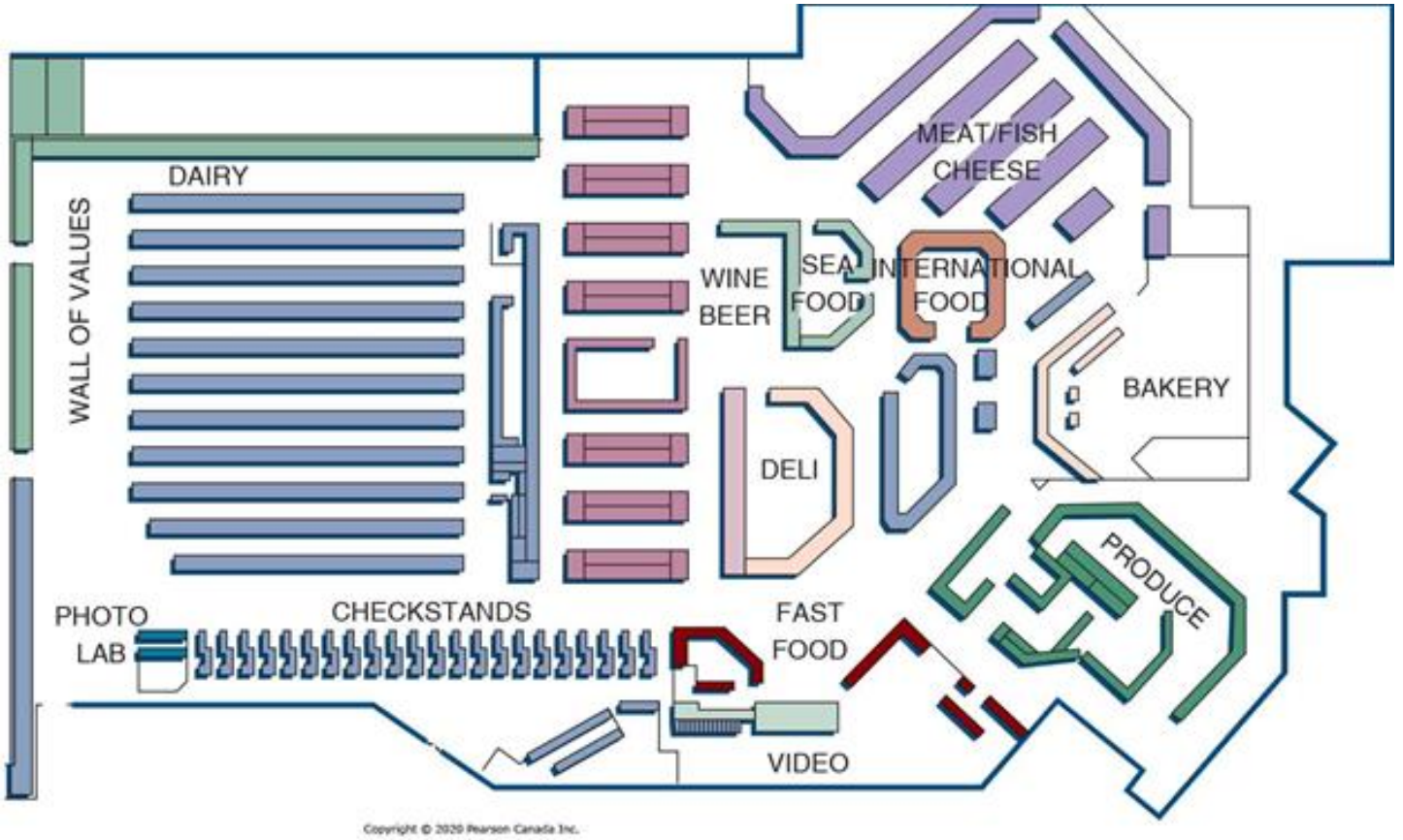
Objective:

- Optimal communication exchange
- Locate workers requiring frequent contact close to one another

Retail Layout

Objective:

- Expose customers to high-margin items
- Maximize profit per square foot



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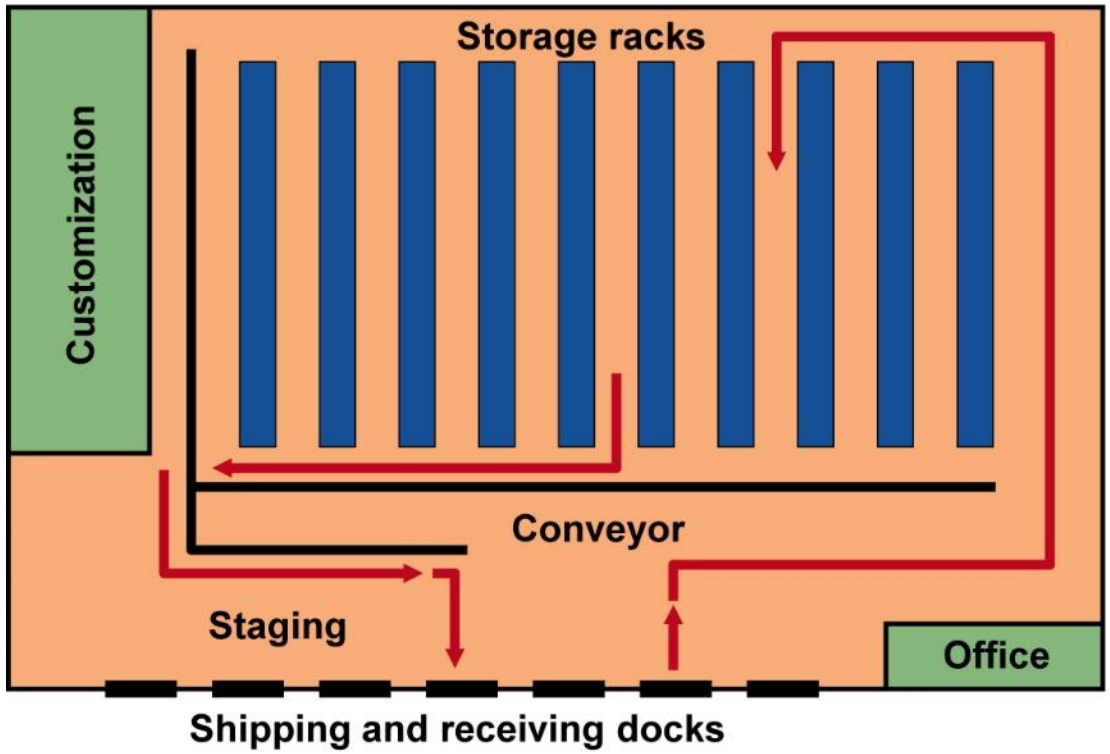
4. Explain each of the layout types, provide some examples, and discuss considerations: warehouse layout

Warehouse Layout

Objective:

- Balance low-cost storage with low-cost material handling
- Optimize trade-offs between handling and storage costs

Traditional Warehouse Layout



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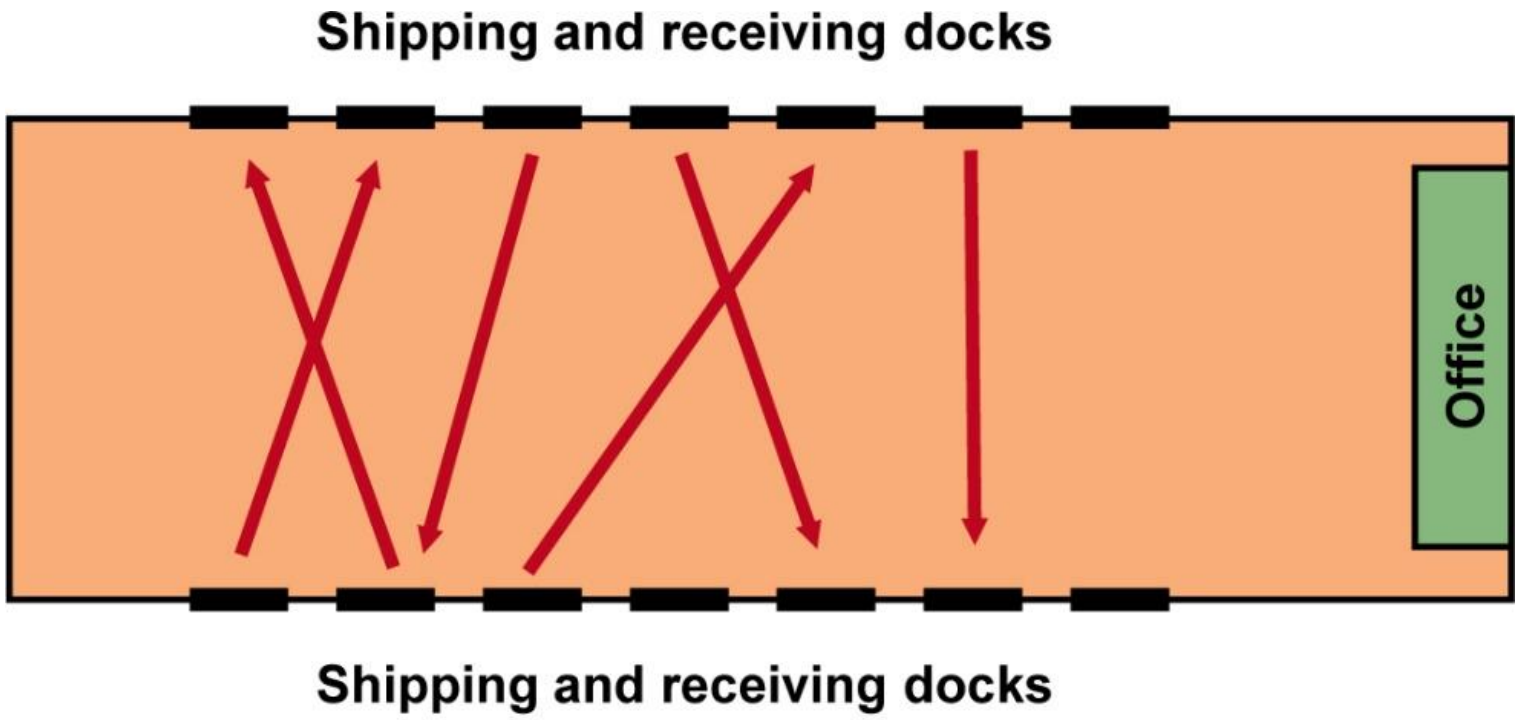
Warehouse Layout

Objective:

- Eliminate the put-away process
- Minimize handling and storage costs

Cross-Dock Warehouse Layout



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5. Explain each of the layout types, provide some examples, and discuss considerations: fixed-position layout.

Project / Fixed – Position Layout

Objective:

- Improve process efficiency by reducing movement and maximizing utility of limited space
- Implement same sequence of processes each time

Small Scale

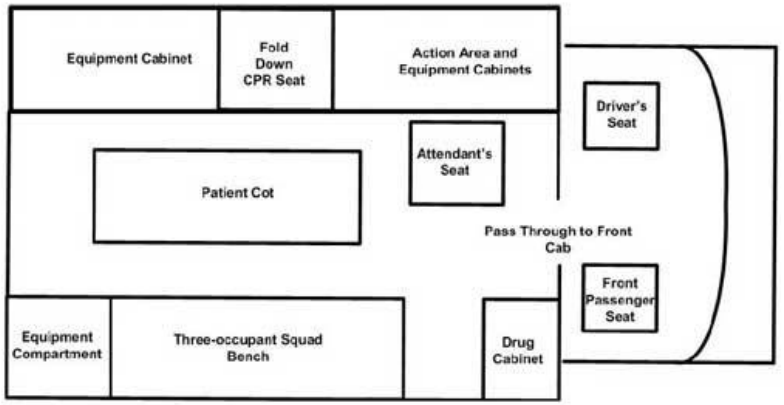
7. Explain each of the layout types, provide some examples, and discuss considerations: work-cell layout

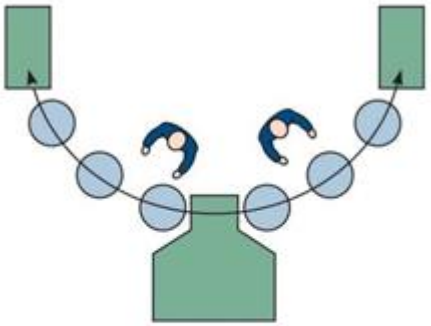
Small Scale

Work Cells

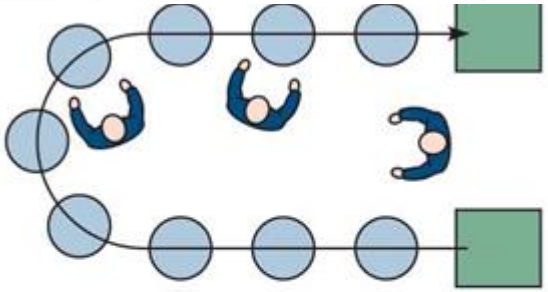
Objective:

- Reduced labor congestion and improved process flexibility
- Achieve custom service/experience
- Achieve flexibility in limited space





Improved layout—cross-trained workers can assist each other. May be able to add a third worker as added output is needed.



Improved layout—in U shape, workers have better access. Four cross-trained workers were reduced to three.

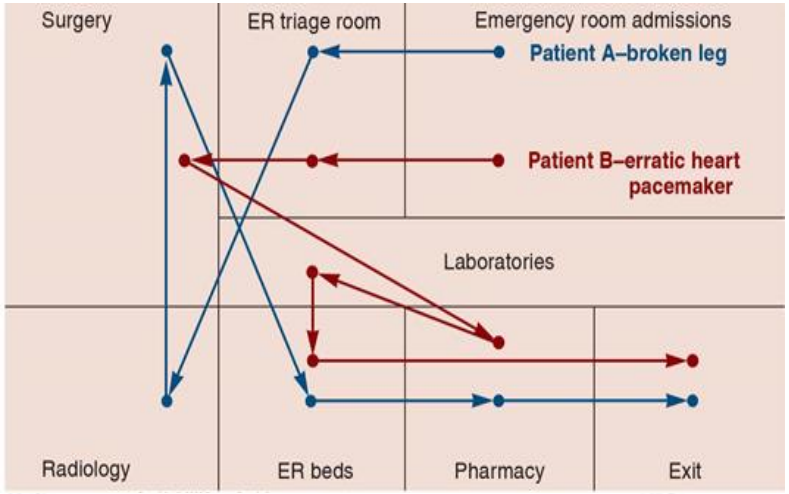
6. Explain each of the layout types, provide some examples, and discuss considerations: process-oriented layout

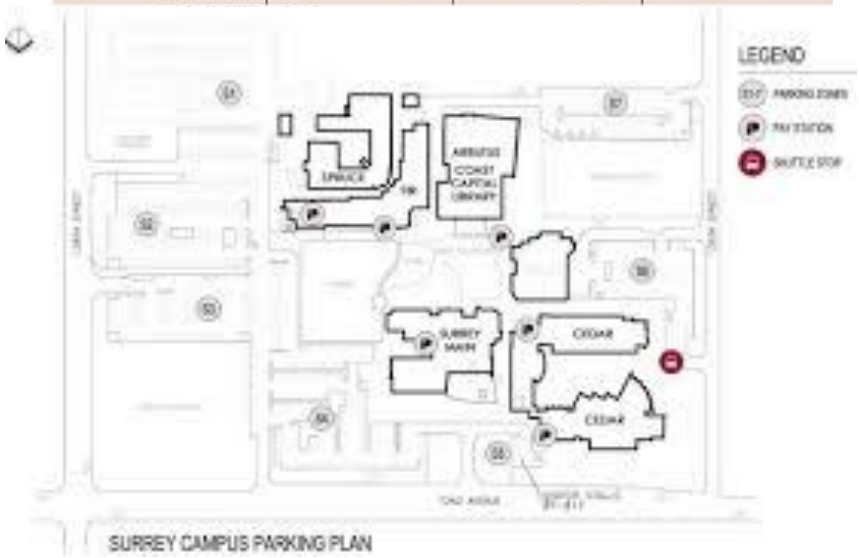
Process-Oriented Layout

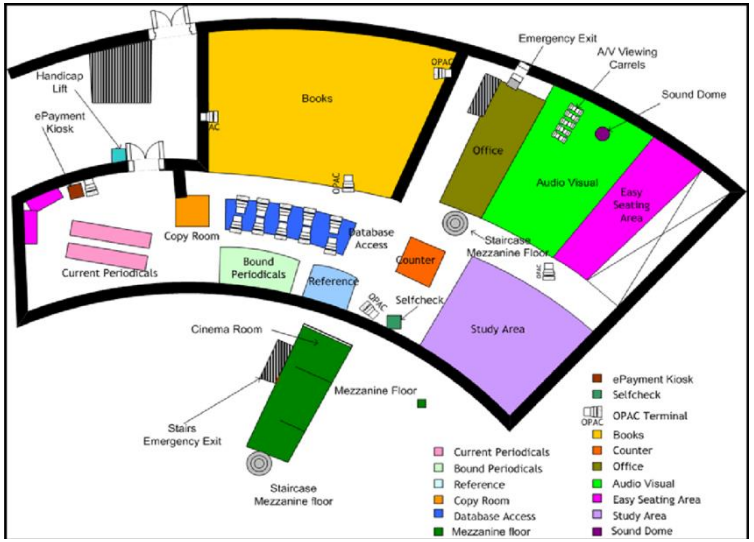
Large Scale

Objective:

- Improve process efficiency via travel time reductions
- Achieve flexibility in large scale facilities





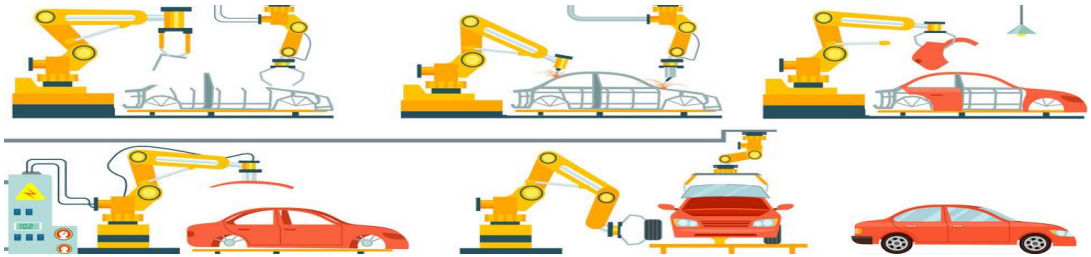


8. Explain each of the layout types, provide some examples, and discuss considerations: repetative and product-oriented layout

Repetitive and Product-Oriented Layout

Objective:

- Equalize the task time at each workstation
- Enhance throughput and reduce idle time at each work station
- Implement same sequence of processes each time
- Enhance efficiency in large scale facilty



Elapsed time	0:00	0:11	0:31	0:45		1:30
Task time (seconds)		11	20	14	0	45
Task	1. Order	2. Bun toasting	3. Assembly with condiments	4. Wrapping of patty with bun	5. Order picked up immediately to keep it fresh	6. Customer service (order and payment)

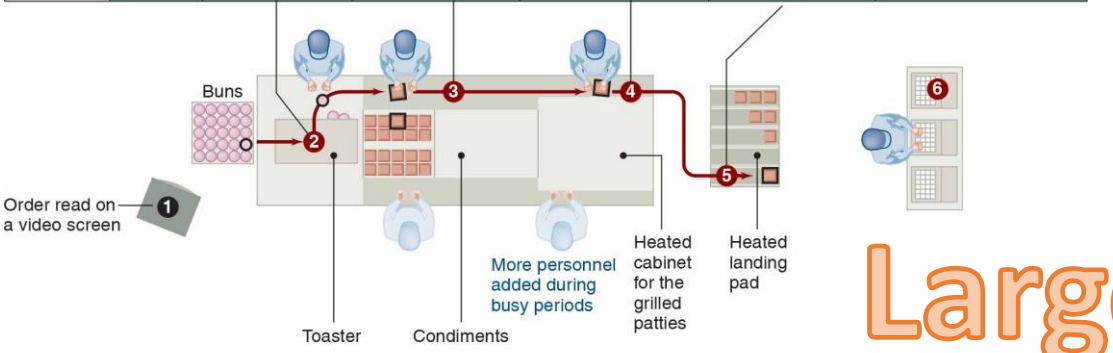


FIGURE 9.11 McDonald's Hamburger Assembly Line

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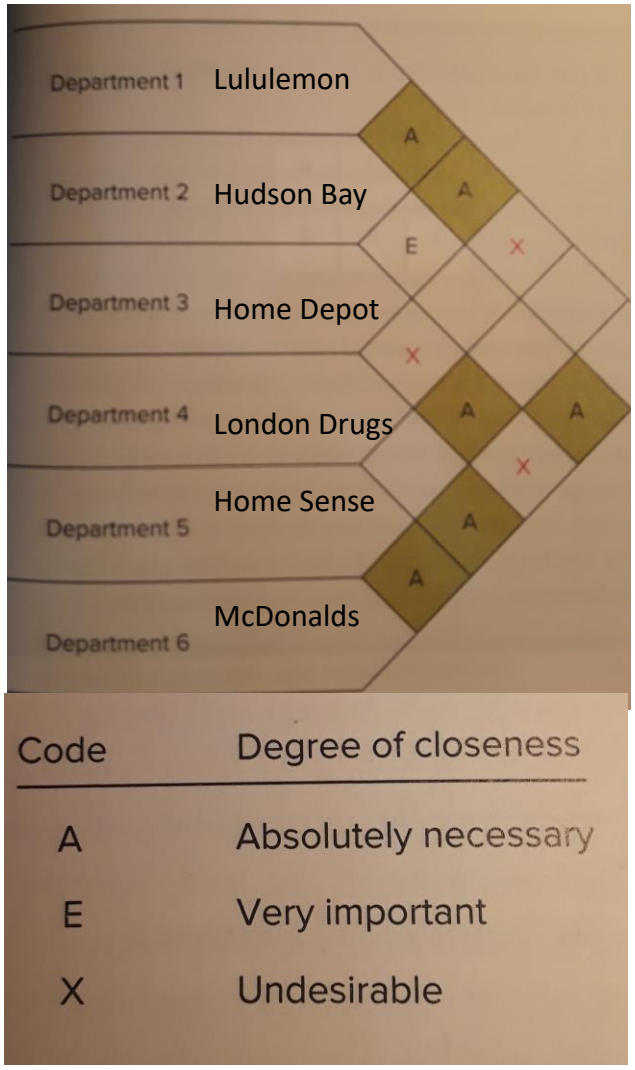
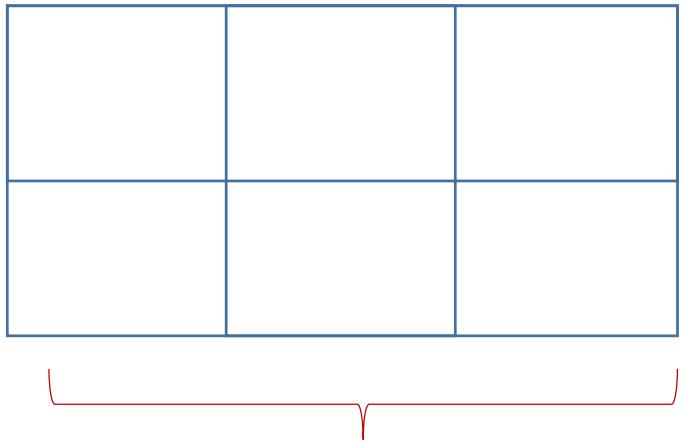
Large Scale

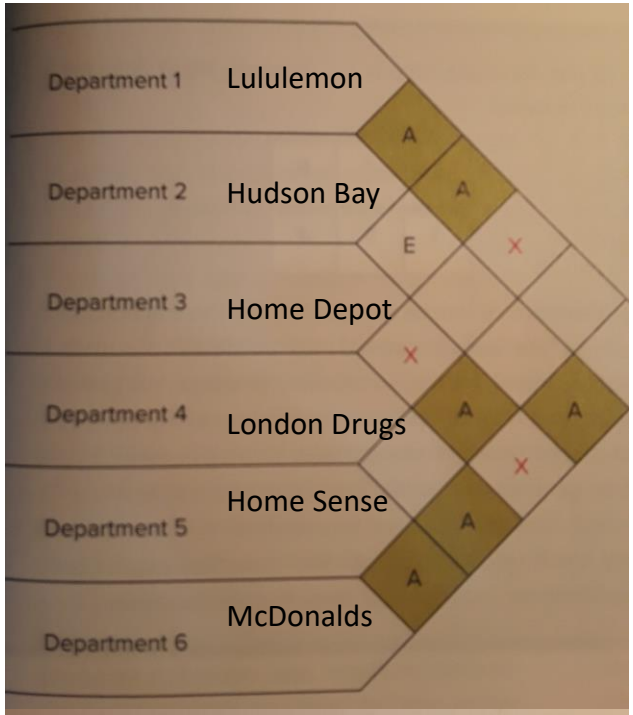
CONCEPT APPLICATION

Relationship Chart – Muther Grid





Where should each Department / Store be located ?

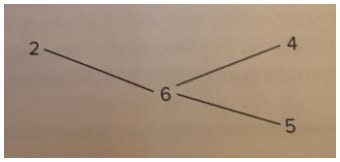


Code	Degree of closeness
A	Absolutely necessary
E	Very important
X	Undesirable

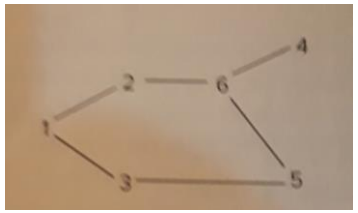
Step 1 – Prepare a list of A and X ratings

A	X
1–2	1–4
1–3	3–4
2–6	3–6
3–5	
4–6	
5–6	

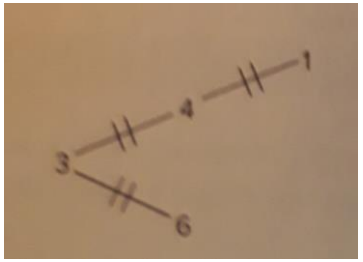
Step 2 – Form a cluster of A links beginning with the department that appears most frequently in the A list



Step 3 – Take the remaining departments in order of number of appearance in the A list, and add them to the main cluster. Form separate clusters for departments that do not link with the main cluster.



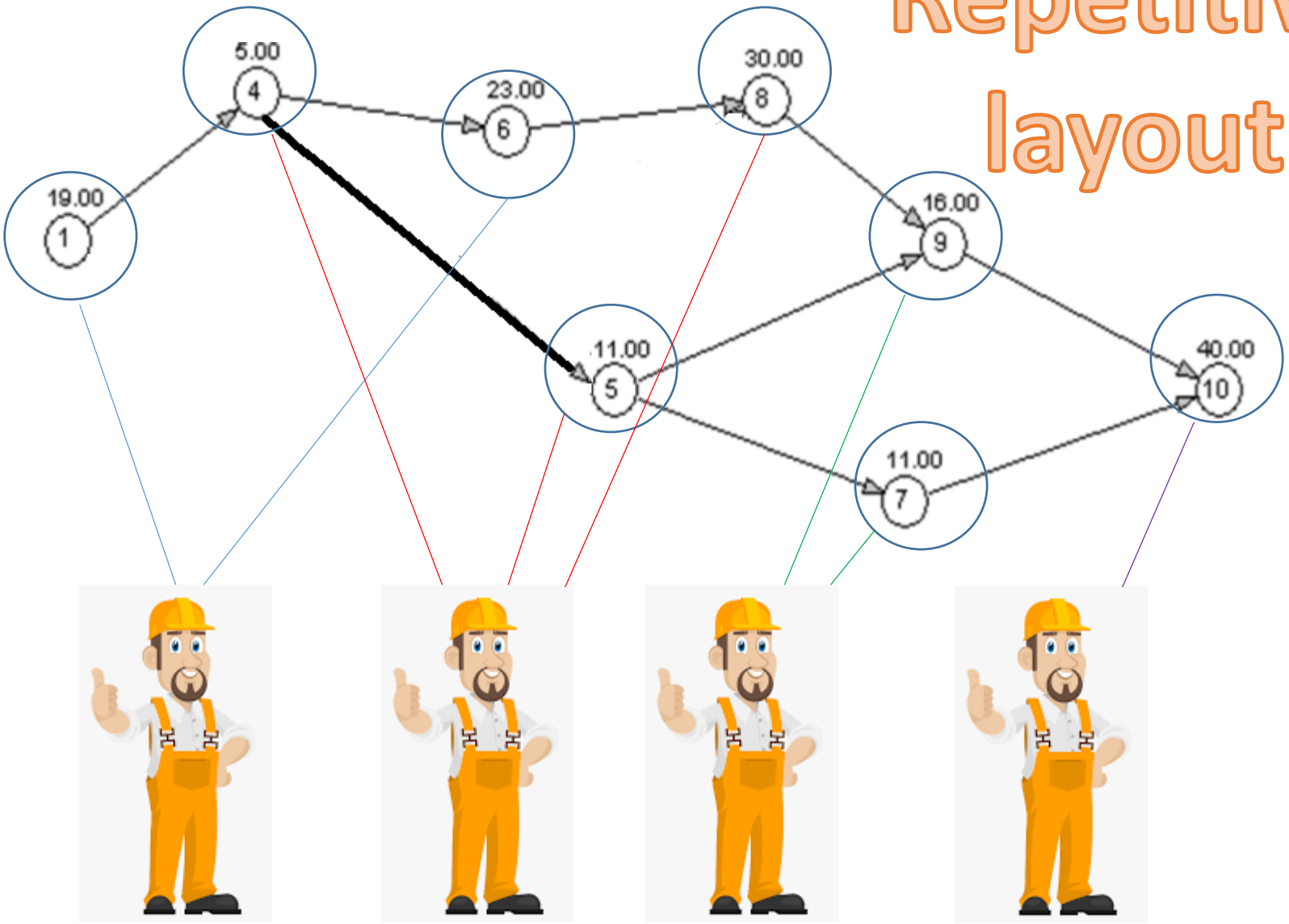
Step 4 – Graphically portray X's as a separation cluster



Step 5 – Fit the A's cluster into a 2 x 3 arrangement that keeps X separations in mind.

Workstation Assignment to Each Worker

Repetitive layout



Workstation / Assembly-Line Balancing = PROCESS OF CREATING SMOOTH ASSEMBLY LINES that are free of idle time. Spread work activities equally among work cells.

Cycle time (or Takt Time) is the maximum time allowed at each workstation to complete its set of tasks on a unit.

Workstation consists of sub-stations.

Balancing Instructions

STEP 1 – Identify **CYCLE TIME** and determine **MINUMUM # OF WORKSTATIONS**

STEP 2 – **ASSIGN SUB-STATIONS** to workstations from **LEFT TO RIGHT**. Start each workstation with Time Left = Cycle Time. After each sub-station, subtract the time of the assigned sub-station from the left time.

STEP 3 – Use the following **CRITERIA TO DETERMINE SUB-STATION ELIGIBILITY & FIT:**

a) all sub-station preceding sub-stations have been assigned
b) sub-station time does not exceed the time left at workstation

STEP 4 – **USE HEURISTICS** to assign sub-stations (and break ties):

a) assign sub-station with longest time
b) assign sub-station with most followers
c) assign sub-station with largest positional power

HEURISTICS CAN CHANGE !!!

STEP 5 – Continue until all sub-stations have been assigned to workstations. **CALCULATE TOTAL IDLE TIME.**

Line Balancing Formulas

$$CT = \frac{OT}{D}$$

$$D = \text{desired output rate}$$

Cycle Time / Takt Time: maximum time allowed at each workstation.

- How much time is required at workstation before moving on?

$$\text{Output capacity} = \frac{OT}{CT}$$

$$OT = \text{operating time per day}$$

$$CT = \text{cycle time}$$

Output Capacity: Desired Output

- How much output desired?

Line Efficiency

$$\text{Percentage of idle time} = \frac{\sum \text{Idle time}}{N_{actual} \times \text{Cycle time}} \times 100$$

$$\text{Efficiency} = 100 - \text{Percentage of idle time}$$

$$N_{min} = \frac{\sum t}{CT}$$

$$N_{min} = \text{Theoretical minimum number of work stations}$$

$$\sum t = \text{sum of the task times}$$

Theoretical Minimum: minimum number of workstations.

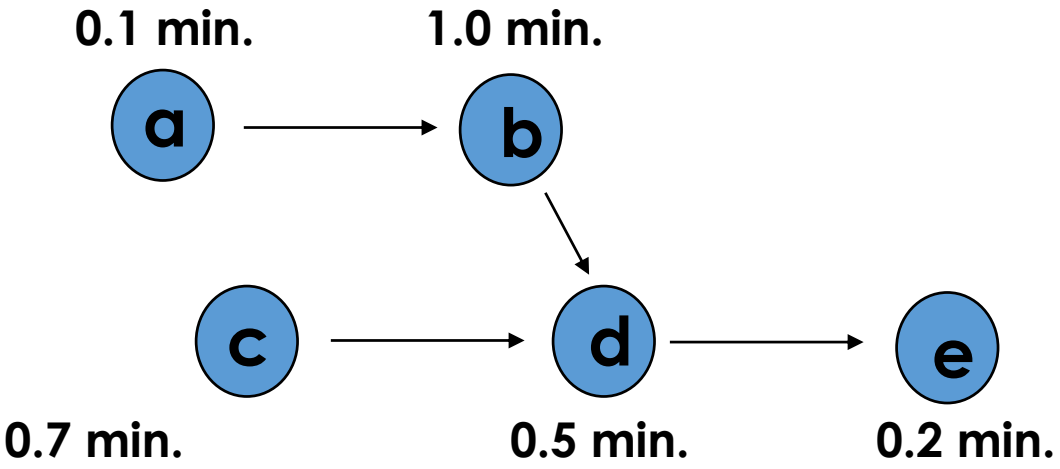
- How many stations to use?

Time of all tasks / T1+T2+T3…

Example: Balancing & Calculating Idle Time

Management desires an output rate of 440 units per day. Assume that 440 minutes are available per day.

- Determine the **CYCLE TIME**, and the **NUMBER OF WORKSTATIONS**
- Assign tasks using the heuristic: most number of followers
- Calculate **LINE EFFICIENCY**



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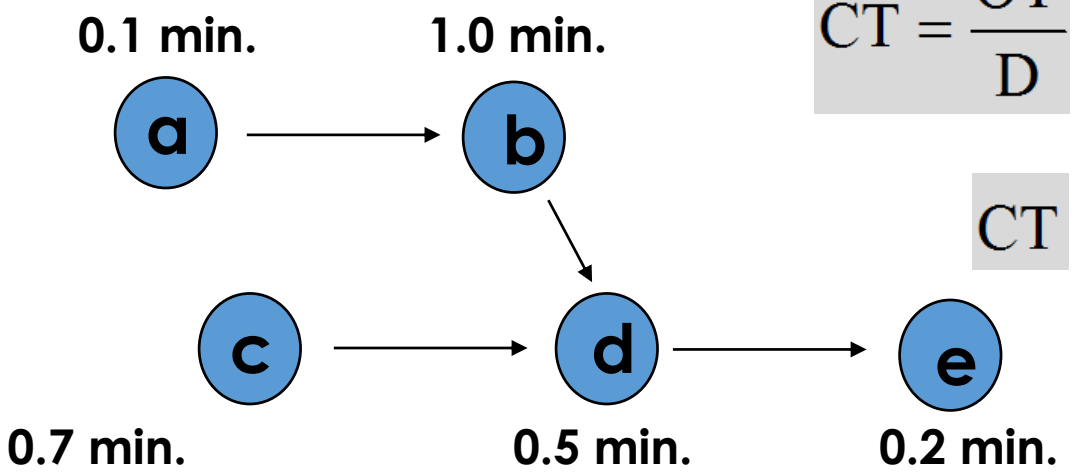
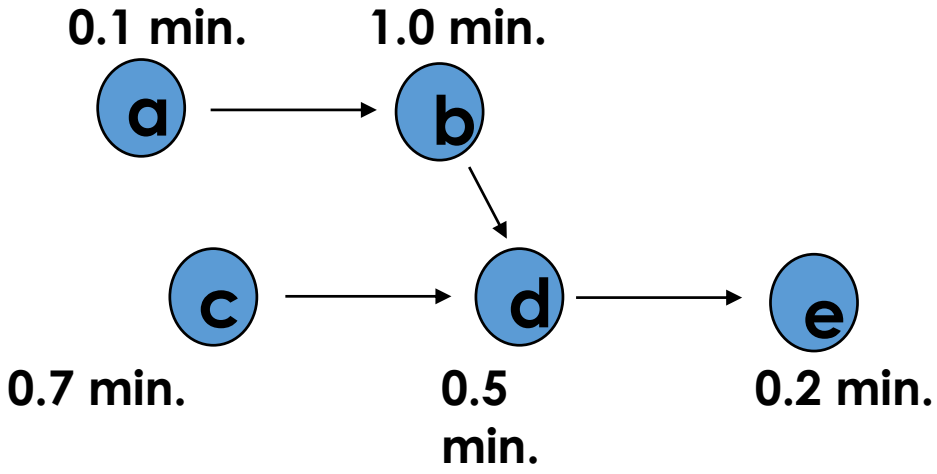


$$CT = \frac{OT}{D} \qquad N_{min} = \frac{\sum t}{CT}$$

CT = 440 minutes per day / 440 units per day = 1

$\sum t$ = 0.1 + 1.0 + 0.7 + 0.5 + 0.2 = 2.5

N_{min} = 2.5/ 1 = 2.5 ⇨ **ROUND UPTO 3**



Workstation	Time Remaining	Eligible	Assign Task	Revised Time Remaining	Station Idle Time

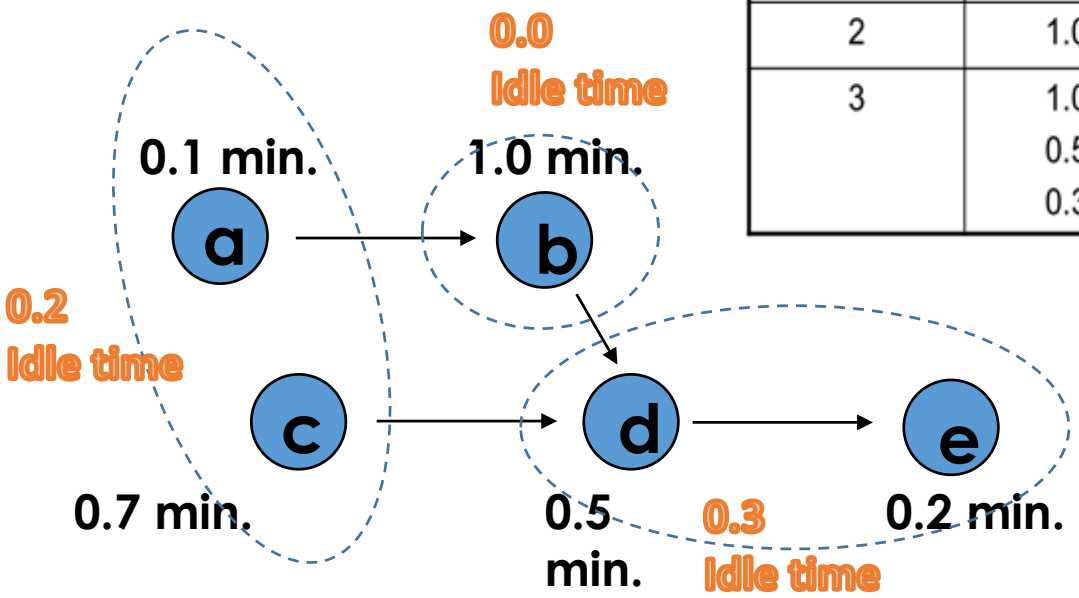
Example: Balancing & Calculating Idle Time

CT = 1

Heuristic: most number of followers

Workstation	Time Remaining	Eligible	Assign Task	Revised Time Remaining	Station Idle Time
1	1.0 0.9 0.2	a, c c	a c -	0.9 0.2	 0.2
2	1.0	b	b	0.0	0.0
3	1.0 0.5 0.3	d e -	d e -	0.5 0.3	 0.3 0.5

Total Idle Time = 0.5



$$\text{Percentage of idle time} = \frac{\sum \text{Idle time}}{N_{actual} \times \text{Cycle time}} \times 100$$

$$\text{Efficiency} = 100 - \text{Percentage of idle time}$$

Example: Calculating Line Efficiency

$$\text{Percentage of idle time} = \frac{\sum \text{Idle time}}{N_{\text{actual}} \times \text{Cycle time}} \times 100$$

$$\text{Efficiency} = 100 - \text{Percentage of idle time}$$

$$\%\ \text{of idle time} = \frac{\sum \text{Idle time}}{N_{\text{actual}} \times \text{Cycle time}} \times 100 = \frac{0.5}{3 \times 1.0} \times 100 = 16.7\%$$

$$\text{efficiency} = 100\% - 16.7\% = 83.3\%$$